I. GRAPE ROTS IN OHIO
II. EXPERIMENTS IN THE PREVENTION OF GRAPE ROT

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Agricultural Experiment Station

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BULLETIN 123

OHIO AGRICULTURAL EXPERIMENT STATION

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BULLETIN

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I. GRAPE ROTS IN OHIO

By A. D SELBY

THE OHIO GRAPE INDUSTRY

The history of the grape industry in Ohio, embracing all its ramifications, is a most interesting one, covering as it must the rise and fall of its several phases of Catawba wine production about Cincinnati, the later wine industry in the "Island" district and latterly the mixed basket grape and wine marketing from an extended belt skirting Lake Erie, and extending from the Pennsylvania border to Port Clinton. In this belt there are now well marked centers of production about Euclid and Dover in Cuyahoga county, respectively east and west of the city of Cleveland, in Lorain county adjacent to the Dover District, and surrounding Unionville, which is situated near the line between Ashtabula and Lake counties.

In general the soils devoted to grape growing in the districts just named, are a dense, whitish silt of low fertility, derived for the most part from the Devonian shale which lies very near the surface in these regions. In Ashtabula and Lake counties, more particularly, sandy or gravelly soils, marking the position of the old lake beach, have been planted in vineyard during the period of unprofitable general farming and profitable grape growing from 1884 to 1897.

This silty soil, locally spoken of as clay soil, has proved the most satisfactory for grape growing, and its adaptability is sometimes stated as being in indirect ratio to its fertility. These matters of growth produced and maturity induced by the respective soils devoted to grape culture are factors of no inconsiderable importance when grape rots prevail.

Following the experiments made in France and in the United States from 1885 to 1889, vineyardists soon learned to master the black rot and mildew which then assailed them, while the industry in Northern Ohio generally flourished and the area in vineyards extended during the decade stated. But the competition from large production of basket grapes in the New York grape belt, and the development of the industry in Michigan and Wisconsin, as well as in other states, where Ohio grapes formerly found a market, following upon the decline of the wine industry, has left Ohio grape growing in a languishing condition.

Beginning conspicuously in 1896 and 1897, rotting of the grapes near the ripening period lessened production, first in Ashtabula county, while this rot subsequently extended westward. The attacks of the grape root-worm became destructive in the Euclid district at about the same time, while competition reduced the price of grapes below that formerly estimated to be the cost of production. The inevitable results of diminished incomes and shrinking land values, where not modified by suburban extension, were soon to be noted, and certain other unfavorable conditions followed; vineyards were occassionally removed but perhaps more often permitted to remain and very frequently neglected.

GRAPE CONDITIONS MORE UNFAVORABLE IN 1898 AND 1899

Matters were not improved for the Ohio grape growers during 1898 and 1899, and a ripe rot, perhaps more properly called the white rot, extended over much greater areas till now in 1900 scarcely a locality is free from it.

It may be thought that a recital of these conditions has little bearing upon the problem of grape rot prevention, but not so from the writer's experience. It has qeen found that a languishing industry offers a very unfavorable basis for successful experimentation. Proper tying, cultivation and pruning are not always contemplated under these circumstances, while many neglected vineyards in every neighborhood are breeding places for fungus spores. More than this the attitude of the public is one of dissatisfaction and distrust, manifesting itself in opposition, sharp criticism and in a general unwillingness either to take measures for the betterment of these conditions or to permit others to do so without obstruction. A picture so clouded is happily relieved by a few active and progressive spirits, ready to aid in every way possible and to extend time and money for the general good. To such, the obligations of the investigator are very great.

THE VARIOUS GRAPE DISEASES

Several diseases prevailing in Ohio require to be mentioned and briefly discussed here, the better to distinguish the most destructive.

The Anthracnose fungus (*Sphaceloma ampelinum* D'By) is found upon the leaves and young stems as well as upon the fruit; it produces sunken spots of a definite outline, usually with a central area of lighter color. Upon the fruit this appearance is well marked and has given rise to the name "bird's-eye-rot." (Fig. I). Grapes attacked in this manner are readily distinguished from those attacked by the other rots because of the difference in appearance and the slower spread of the trouble; such as are badly marked, like those in the illustration, are unfit for market. The losses from anthracnose are commonly not large. This disease may be entirely prevented by the use of Bordeaux mixture as directed in the calendar.

A Bitter Rot of the grape is likewise known; it is late in making its appearance and the rotted grapes have a very bitter taste; not known to be important with us. (The fungus of bitter rot is *Melanconium fuligineum* Scribner & Viala).

Downy Mildew or Brown Rot is a somewhat common fungous disease of the grape. The fungus of this mildew (*Plasmopara viticola* (B. & C.) Ber. & D'Ton.) may be discovered upon the leaves by the slight yellow spotting of the upper leaf surface while there is a downy, felted covering of the under surface. A great abundance of summer spores is also produced upon these felted spots beneath. Resting spores are produced within the leaves in the form of "oospores," which will be destroyed by burning the fallen leaves. This same fungus also attacks the grape berry causing brown rot, in which the berries are light brown in color throughout. (See Bulletin, Vol. III, No. 10). Spraying with Bordeaux mixture will prevent both forms of the downy mildew trouble if the work be thoroughly done as directed.

The Powdery Mildew fungus (*Uncinula necator* Schw.) attacks both leaves and fruit of unsprayed grapes in the form of a white web-like covering. For this also, Bordeaux mixture is a specific.

Grape Canker or Frost Injury shows as enlargements upon the older vines at points injured by freezing. These enlargements do not indicate more than healing growth.

Crown Gall may come on nursery vines as excrescences near the surface of the earth; it is a contagious disease, calling for the burning of all infected vines.

Phylloxera is an insect trouble apparent as warty enlargements upon the under leaf surfaces of European strains like Delaware, Brighton and others; the excrescences are often covered with the powdery mildew fungus. It does not attack pure American sorts.

(For Grape Root Worm see Bulletin 62, by the Entomologist of this Station).

Black Rot is also to be referred to a fungus (*Laestadia Bidwellii* (Ell.) Viala & Ravaz.) and ranks as one of the most destructive grape troubles. Some of the earlier achievements of the vegetable Pathologist dealt with this fungus and attained its satisfactory and profitable control. It attacks young stems, the leaves and the young fruit, being especially destructive on the latter. Discussion has been reserved to be placed in juxtaposition to that of white rot.

Upon the young stems and the leaves the black rot fungus produces small, brown-colored spots, often containing the pycnidial pustules of the fungus. (Fig. 2). The damage to the leaves and shoots is possibly quite slight but its occurrence upon them should not be neglected. These dead, brown spots in the leaves are an unfailing indication of the presence of the black rot in the vineyard and mark unerringly the need for treatment to save the fruit. Black rot attacks the fruit when it is yet very small, causing wholesale destruction of the berries while no larger than medium sized shot. The grape crop may be utterly lost at this stage from black rot by omitting what was this season the fourth spraying (but is ordinarily the third spraying), in the experiments described on pages 96-102.

Upon the green fruit until more than half-grown, the black rot fungus causes small, dark, sunken areas in which may be seen with a magnifying glass the pin-head pustules characteristic of that stage of the fungus and of the same character as the similar spots in the dead areas of the leaves and young stems. Black rot usually ceases its destructive spread by the midseason and for this reason a limited number of spray treatments are often successful; but in no case may success be expected if the treatments just before and just after blooming be omitted. Upon the omission of that just before the blossoming period consult page 101.

White Rot or Ripe Rot is the second very destructive fungous disease with which the grape grower must now contend in Ohio. The fungus in question has not been fully studied although many examinations of specimens have been made; it is referred to that of white rot (*Coniothyrium diplodiella* (Speg.) Sacc.) (Scribner, An. Rept. U. S. Dept. Agric.. 1888, pp. 325-6, and Fungus Diseases of the Grape, etc., pp. 41-44). Scribner mentions this as having been discovered in Italy in 1878, in France in 1885 and in southwestern Missouri and in neighboring parts of Indian Territory in 1887. Scribner, in the paper just named, refers to the probable efficiency of Bordeaux mixture for the white rot.

Owing either to limited distribution of the fungus or to the lack of field recognition what is here referred to as white rot comes to us without well demonstrated treatment for its prevention. It begins as small, brown colored, rotted spots in the grape, usually after the middle of June, finally involving the whole grape and showing

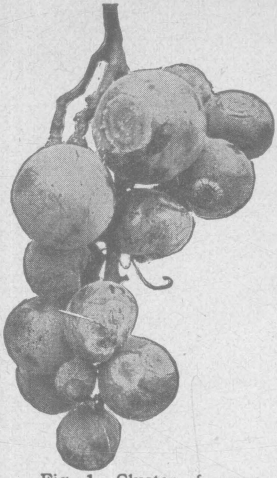
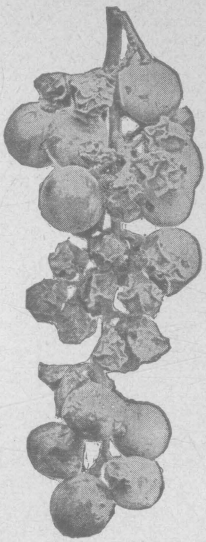


Fig. 1. Cluster of grapes attacked by anthracnose causing bird's-eye rot.



Fig, 3. Cluster of grapes attacked by black rot; the rotted grapes have shriveled in drying. Erroneously referred to white-rot in the original edition of bulletin.

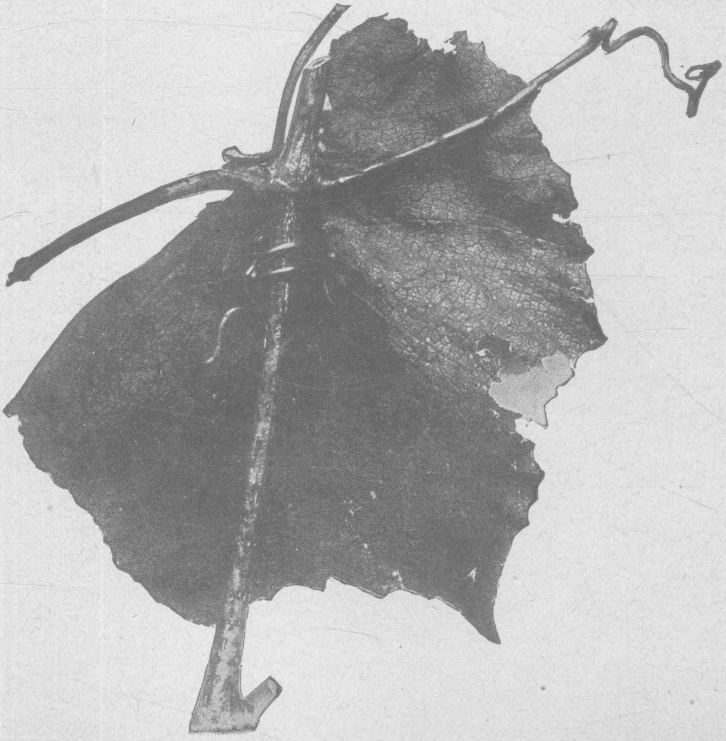


Fig. 2. Leaf and stem of grape attacked by black-rot causing dead areas.

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somewhat darker colored pustules in the rotted area. The whole grape when rotted, is at first of a light brown color; subsequently as the rotted grape dries up the pustule spots become whitish in color and somewhat more prominent. (Fig. 3).

June 27th, 1899, this rot became obvious at Geneva, Ohio. It was very bad June 29th, and became still worse July 9th to 12th. At this same point June 23rd, 1900, it was observed on one or two vines on the dwelling house, and was at its worst in the vineyards August 3-10. The Concord grapes were coloring rapidly August 21, 1900, and picking was begun on early varieties (Moore's Early, etc.,) August 29th; the later varieties September 10th. *In other words this rot almost immediately precedes ripening of the grapes.*

During favorable weather periods this rot spreads quite rapidly and does not seem to yield readily to fungicides. Altogether the four years of continued white rot ravages in Ashtabula county, and slightly shorter periods of destruction in western Cuyahoga and Lorain counties have seriously threatened the grape industry on soils that are at all adapted to other crops or to other purposes.

THE AMOUNT OF ROT INFLUENCED BY SOIL AND VARIETY

Under this caption we are dealing chiefly with the white rot but much of what is stated may be found to apply to black rot as well. Certain varieties of grapes are apparently much more susceptible to the attacks of the white rot. Of the various varieties grown, such as the Concord, Worden, Moore's Early, Niagara, Salem, Delaware, Catawba, Ive's and Norton's Virginia, we may distinguish tentatively at least three classes. Among those most susceptible to rot the Catawba ranks first, followed by the Niagara, Worden and possibly Gorton's Virginia. Among those least readily attacked we may place Moore's Early, Delaware, Salem and Wyandot Red. It seems there is a third group of varieties ranking between these in which we may place the Concord, Ive's and some other varieties. This division is based upon somewhat limited observation and may be locally modified, as between the nonsusceptible and middle classes, by the past history and particular situation of vineyards of certain varieties. For illustration, the Delaware is usually rated high in rot resistance where the Concord may be put rather low, yet there are instances in which the Delaware vineyards rotted as badly or even worse than the Concord but a short distance away on the same sort of soil. Should this form of rot prove as persistent and as general as the black rot it will lead to the abandonment of varieties like the Catawba in some of the grape districts. On the other hand, given the varieties generally planted and there are marked differences on the various soils devoted to grape culture.

It is, of course, to be borne in mind that no comparison can be instituted between different varieties on different soils. What follows has reference to observations made on the same varieties, grown upon different soils and in the same or adjacent vineyards. The tendency of the gravelly soils and those of a more loamy character is to cause a more vigorous growth and a greater density of foliage as well as a greater length of wood. In general there is a greater tendency to rot on vines with this character of growth. Whether the explanation be in the maturity of the growth or in the shading and higher humidity, or in a constitutional tendency, can scarcely be stated. The writer inclines to attribute influences to each of these factors.

Where the soils are of the hard, white, silty character before described, those usually called hard, clay soil, with the shale commonly near the surface, or at a greater depth as the case may be, this rot is much less destructive. The growth of the vines is usually much less and the amount of shade is also less but it would appear that the growth matures sooner and general conditions of greater resistance to fungus attack is found invines of this character.

THE PROBLEM OF ROT PREVENTION AND ITS DIFFICULTIES

In the matter of rot prevention we may include both black rot and the other, which we call white rot, and for the districts under discussion I can offer very little encouragement to those who would expect even occasional crops of grapes without spray treatment with fungicides. It is equally true that this spray treatment must accomplish the prevention of both black rot and white rot.

The prevention of black rot is not especially difficult under normal conditions and is very generally attained by only a few spray treatments with Bordeaux mixture; the first spraying as the buds are swelling; a second just before blossoming and the third, after the blossoms drop. This applies to nearly all varieties and to soils of every character.

It is not clear that these treatments, extending from May 10 to June 20-25, can be rated very high in the prevention of white rot, although if these early sprayings are omitted there will commonly be few grapes to save from the white rot. Manifestly a spray treatment which is to be effective against white rot must be repeated at very frequent intervals and with a close watch on general conditions. The principal to follow is to spray before the onslaught of the disease.

Another limit in the use of Bordeaux mixture is stated by the date of the ripening of the grapes, so that ordinary Bordeaux mixture can scarcely be applied with safety after early in July.

While referring to the details given in the experiments on pages 96-102, with results obtained from them, one can readily perceive the approximate aid of the several sprayings and the mixture applied.

It does not appear that the standard Bordeaux mixture is less effective than one of greater strength and there is apparently no need for changing the 4 and 4 formula (seventy-five gallon formula*) so long and successfully applied by this Station.

While ammoniacal copper carbonate is apparently as effective and satisfactory as *eau celeste*, there is need for some better fungicide to apply just before the coloring of the grapes, however, if one or two more applications of Bordeaux mixture are made by shortening the intervals it might be that this would prove more effective. In this line the work of next season will be pushed.

There is also room for a trial of Bordeaux mixture made with some other alkali than lime, say with caustic soda of commercial grade, after the manner of that used by Halsted in various spraying experiments in New Jersey. (Report of New Jersey Experiment Station, 1896).

From Halsted's results one infers that soda Bordeaux mixture is equally as effective as the standard Bordeaux mixture. One would hope that it would prove less adhesive than standard Bordeaux while rather more actively effective than the *eau celeste* and ammoniacal copper carbonate. The prospects for a rot prevention appear to lie in the lines just indicated.

THE FUTURE OF OHIO GRAPE GROWING

This topic is considered in respect to the problem of rot prevention in relation to that of market price. One may anticipate good prospects, for grape growing on a small scale near home by reason of those conditions heretofore discussed, since in these scattered localities the matter of rot prevention has proved much less serious; but in grape growing districts the future is scarcely encouraging though it is well worth while to continue to work on spraying for that is the chief hope of a favorable outcome. But the spraying must be done with great thoroughness and careful attention to details in order to succeed. It would appear that power or traction appliances, which will admit of frequent stopping of the spray cart, as well as the use of long hose, at least 25 feet, will lead to more thorough work than present practices. The nozzle must throw a fine spray secured by pressure from the pump, and the spray must be directed to cover all parts properly.

With the modifications of spraying treatment above indicated we may hope for very satisfactory results under average conditions. By average conditions is meant with the fairly resistant varieties, such as the Concord, upon soils really adapted to grape culture. It may prove impracticable to endeavor to save the grapes upon fertile soils where growth is luxuriant, and likewise of doubtful profit to grow varieties ranking as highly susceptible to rot.

* The original formula of six pounds of copper sulfate to 50 gallons was called by Fairchild, "the fifty gallon formula;" that of four pounds to 50 gallons, therefore the seventy-five gallon formula, because 75 gallons of mixture are required to contain 6 pounds of copper sulfate.

The future is in the hands of the vineyardists and it certainly encourages no half-way efforts. It would seem wiser to remove the grapes from soils favorable to rot than to continue a losing battle; however, I am not yet convinced that the battle is to be a losing one on the typical grape soils of Ohio. It is certainly to be recommended that vineyards either be cared for or be removed, since neglected vineyards are a source of infection to those who would endeavor to save their grapes from rot and other troubles.

II. EXPERIMENTS IN THE PREVENTION OF GRAPE ROT.

By A. D. SELBY AND J. F. HICKS.

In July, 1899, Mr. F. D. Wilson, of Geneva, Ashtabula county, called attention to the destructive prevalence of rot in grapes on his premises and in the vicinity. The Station Botanist visited the region early in August of that year and found conditions as represented. But little spraying had been done in the vicinity and much that had been undertaken was of a desultory character. The losses from rot were very heavy throughout the immediate region, and in the absence of definite results from treatment it was deemed advisable to undertake experiments in 1900, if feasible.

Arrangements were accordingly made early the present season for spraying experiments on a leased vineyard of four acres of the Concord variety, adjoining the premises of Mr. Wilson, and under lease by him. The experiments to be described hereafter, were conducted in co-operation with Mr. Wilson, upon this "Brakeman" tract, the spraying operations being under the immediate direction of Mr. J. F. Hicks, Assistant Botanist of the Station. In addition to the completed experiments on the Brakeman tract, however, a plan intended to develop similar results was followed upon the vineyard of Mr. Wilson, consisting of mixed varieties of grapes. Brief references will be found to this part of the work, although very little benefit was realized from the treatment of the Wilson vineyard. The work was based upon results obtained by the Station Horticulturist on the Station vineyard, and somewhat with reference to the local work on the vineyards and on other plants. The experiments of this Station many years ago having demonstrated the superiority of Bordeaux mixture, where it can be used, over Eau Celeste and other copper compounds, as well as the equal efficiency of the 4 pound strength of this mixture, 75 gallon formula,

it was deemed best to use Bordeaux mixture of this strength, 4 pounds of copper sulfate and 4 pounds of lime to 50 gallons of water as the standard fungicide, so long as possible. Stronger Bordeaux mixture of 6 pound and 8 pound strengths, respectively, to 50 gallons of water, were also included, as were spray solutions of formalin (40 percent formaldehyde), salicylate of soda and salicylic acid with lime. Winter treatment was made, while for certain rows otherwise subjected to the same treatment one each of the various strengths was omitted. This series of omissions furnishes some valuable information. It is hoped that the diagram annexed will give a sufficiently clear and concise statement of the various sprayings given the several portions of the vineyard.

(Diagram)

TABLE I. SUMMARY OF SPRAYINGS ON BRAKEMAN VINEYARD.

(Beginning at south side)

Row	1	Sprayed eight times — On 1 and 2 Bordeaux 6 lbs. copper sulfate.
"	2	" " "
"	3	" " " — Stronger Bordeaux first spraying only.
"	4	" " "
"	5	" " "
"	6	" " "
"	7	" " " — East one-fifth, seventh spraying omitted.
"	8	" " "
"	9	" " " — Bordeaux mixture for sixth spraying.
"	10	" " "
"	11	" seven times—Omitted fourth spraying.
"	12	" eight times.
"	13	" seven times—Omitted third spraying.
"	14	" eight times
"	15	" seven times—Omitted second spraying.
"	16	" eight times
"	17	" eight times — Copper sulfate solution on these for first and second spraying East one-third
"	18	" " " " — No. 18 omitted second spraying.
"	19	" " " "
"	20	" eight times using only Formalin, 1 lb. to 20 gallons.
"	21	" eight times — West ½ salicylic acid ¼ lb. lime 2 lbs. to 10 gallons water. East ½ salicylate soda ¼ lb. to 10 gallons water.
"	22	" seven times—Omitted first spraying.
"	23	Unsprayed.

Unless otherwise stated, sprayings first to fifth inclusive were of Bordeaux mixture I of spray calendar, 4 lbs. copper sulfate, 4 lbs. lime to 50 gallons. Sprayings sixth to eighth were with ammoniacal copper carbonate as per calendar.

DATES OF SPRAYINGS.

First—April 18.
Second—May 10.
Third—May 28.
Fourth—June 22 and 23.
Fifth—July 2 and 3.
Sixth—July 12 (with am. copper carb.)
Seventh—July 27.
Eighth—August 14 and 15.

The vineyard is 46 rods long and consists of 23 rows 10 feet apart, extending east and west. The soil is gravelly, the area sloping very gently to the west with lowest land in northwest corner. Other inequalities of elevation are slight. The grapes were pruned to three canes and tied; the whole being put in good order. The old rotted grapes were gathered from vines, wires, etc., during the early part of the spring, There was a very good promise of buds, but a freeze on May 11th, just as the buds were beginning to open, injured the prospect very greatly, and somewhat unevenly. The areas of greater injury were toward the south side.

The spraying in the work was done, except for the first application, by means of a Morrill & Morley pump, mounted on a 50 gallon barrel, and connecting with two 25 foot lines of hose, each carrying a double Vermorel nozzel. One person manipulated the pump and one was at each line of hose. The first application was made with a traction pump and short hose, admitting of only approximate thoroughness. For the applications after the first, thoroughness was attained by frequent stopping and spraying until the vines, posts, etc., were dripping; during the earlier sprayings attention was given to covering the fallen, rotted grapes with the spray. The following table shows the area sprayed, amount of mixture used, and time consumed for the whole area receiving copper compounds, as well as those several items computed per acre. Attention is called to the use of almost 150 gallons of mixture per acre (average 2.9 barrels of 50 gallons each) for each of the five later applications. The details are shown in the table itself.

TABLE II: SUMMARY OF TIME AND MATERIALS CONSUMED ON AREA SPRAYED WITH BORDEAUX MIXTURE AND COPPER CARBONATE; ALSO STATEMENT OF TIME AND AMOUNTS PER ACRE SPRAYED WITH SAME.

Spraying and Date.	Total area sprayed acres	Hours for crew	Barrels of mixture each 50 gallons	Pounds copper sulfate or copper carbonate	Acres sprayed per hour	Hours per acre	Barrels of mixture per acre
First, April 18, 1900							
Second, May 10, 1900	3.3	10	6½	27½	.33	3.0	1.9
Third, May 28, 1900	3.3	10½	6½	28	.31	3.2	1.97
Fourth, June 22-3, 1900	3.3	10	9½	40	.33	3.0	2.9
Fifth, July 2-3, 1900	3.3	11	10	42	.30	3.3	3.0
Sixth, July 12, 1900	3.4	10	10	3.6	.34	2.9	2.9
Seventh, July 27, 1900	3.4	10	10	3.7	.34	2.9	2.9
Eighth, August 14, 1900	3.4	11	10	3.7	.31	3.2	2.9

In general, with help accustomed to the work and with the conveniences not very marked, one barrel or 50 gallons of mixture may be applied per hour or 10 barrels per day.

From this table we may arrive at the cost per acre of the several applications from the 2nd to the 8th, inclusive. This appears to have been as follows:—

COST OF VINEYARD SPRAYING PER ACRE

Time for crew, 3 hours per acre, 7 sprayings 21 hours at 35 cents per hour	$7.35
10 barrels of Bordeaux mixture, 4 sprayings at 25 cents per barrel	2.50
7 7 barrels Am. Cop. Carbonate at 20 cents per barrel, three sprayings	1.54
	$11.39

These figures may be somewhat reduced with better conveniences, such as larger spray tank, more convenient water supply, and working on a more extensive scale. The reduction will consist, for thorough work, more largely in reduction of the labor item; the amount of mixture stated is very near to the necessities for thorough work

The black rot appeared at the usual peroid, destroying nearly the whole crop on rows 13 and 23; there was also an apparent lack of efficiency of the salicylate of soda and salicylic acid-lime solutions to protect satisfactorily from black rot. Row 13, which received all the sprayings except the third, made May 28th, just previous to the blossoming of the grapes, fared but slightly better than the unsprayed row. The first white rot was observed in the vineyard about June 25th, it was very destructive August 3rd to 12th. Clusters freed from rotted grapes and dipped in the ammoniacal copper carbonate solution employed for spraying purposes suffered about as much from rot as those receiving only the sprays applied. During the time of most disastrous rotting the weather was hot and "steamy". The crop was gathered and marketed in small quantities, being put up in four pound baskets. The following table gives the yields of the several rows both in four pound baskets and in pounds of wine grapes subsequently gathered. We are under obligations to Mr. Wilson for this part of the record:—

TABLE III: YIELD OF GRAPES FROM THE BRAKEMAN VINEYARD.

No. of Row	Pounds of wine grapes sold	Baskets 40 lbs each, marketable grapes	Remarks.
1	10	101	Bordeaux mixture of greater strength on rows 1&2
2	20	93	See Table I
3	30	83	
4	20	73	Standard
5	30	80	Standard
6	45	98	15 baskets, East one-fifth
7	45	85	Standard
8	70	87	No apparent advantage from use of Bordeaux
9	55	69	Mixture for sixth spraying
10	40	104	Standard
11	65	100	Spray omitted just after blooming
12	45	102	Standard
13	121	10	Spray omitted on new shoots
14	56	104	Standard
15	42	102	Spray omitted on opening buds
16	73	102	Standard
17	62	99	Copper sulfate on rows 17, 18 and 19, apparently
18	63	84	not more efficient than Bordeaux mixture.
19	46	47	
20	11	....	Formalin solution a failure
21	15	...	Salicylic acid and compounds a failure
22	60	62	Bordeaux mixture and cop. carbonate on this row
23	....	...	Unsprayed

Rows 1 to 8, iuclusive, show a slightly lower yeild in baskets than Rows 10 to 12 and 14 to 18, inclusive. Row 19 indicates, possibly, the proximity of a badly rotted row, although Row 22 in a more unfavorable situation has a slightly better yield. The ragged clusters of No. 13 are indicated in the increased amount of wine grapes. Row 13 certainly teaches the efficacy of the spraying which should be made immediately preceding the blossoming of the grapes, on the new shoots of the vine. Row 9, which received Bordeaux mixture for sixth application instead of ammoniacal copper carbonate, yields unfavorable results. No sufficient explanation is at hand. There was different pruning given a portion of Row 1, so that the slightly increased yields of Rows 1 and 2 do not indicate a decidedly increased efficiency for the stronger Bordeaux mixture. No difference whatever was observed as between this strength and twice the usual formula in the Wilson tract, where most of the crop rotted despite the spraying made at about the same peroids as those detailed for the Brakeman tract.

On Row 22 the first spraying was omitted; on Row 15, the second; on Row 11 the fourth spraying was likewise omitted. The results fail to indicate loss therefrom, although there might have been some equalizing of the possibly more scattered clusters on Row 11 by the white rot. This rot spread rapidly in dense clusters. Formalin, salicylate of soda and salicylic acid with lime are of about equal value in spraying and show a total loss of grapes, marketable in baskets.

The maximum results of the spraying, as represented by Rows 10, 11, 12, 14, 15, 16, 17, and 18, indicate that 50 percent of the possible crop was saved by the treatment, as the yield upon these represent about one-fourth a crop. The estimated loss from white rot on this same area is placed at about the same amount.

RESULTS OF OTHER SPRAYING OPERATIONS IN THE SAME REGION

Extensive spraying of grapes during the season was carried on by Mr. E. N. Warner, Unionville, and on the "Highland Farm," next Mr. Warner's, which is directed by Mr. O. M. Stafford, of Cleveland, with Mr. Clayton H. Goodrich as Manager.

Mr. Warner applied the spray to about 40 acres and gathered a yield of 18,000 baskets of 8 lbs. each, and 28,000 of 4 lbs. each, or by combination say 32,000 eight pound baskets against 15,000 baskets in 1899. He estimates a good yield at 40,000 baskets of 8 lbs. size; also that without spraying he should have gathered no grapes in 1900. This last statement is supported by the experience of those who did not spray. A neighbor, Mr. Dilley, for whom Mr. Warner did spraying, had a yield of 3,000 baskets against 300 in 1899.

From the Highland Farm vineyards of 80 acres no grapes were picked in 1899. In 1900, the yield amounted to 18,000 baskets of 8 lbs. each, chiefly from about half the area. In these instances, as indeed in the common practice at present, traction sprayers were used, kept constantly moving forward and with men to direct the nozzles. The amount of mixture required by spraying in this manner is very much less than by thorough drenching of the vines. It would appear that Mr. Warner's vineyards are more favorably situated to resist rot than those of Highland Farm; indeed, certain areas belonging to Mr. Warner suffered severly, while others were almost entirely saved. Mr. Thos. Reed of Harpersfield has been spraying for some years but suffered considerable losses; his experience is in line with that on Highland Farm. In an article published in the Geneva, Ohio, "Free Press" of October 13, 1900, Mr. Warner expresses the opinion that the grape rot may be eradicated by continued spraying during about three years. Were all results as favorable as those of Mr. Warner himself, so hopeful a view might properly be entertained. As the results now stand, however, we should be prepared to continue the battle somewhat longer. With thorough treatment on favorable soils, a profitable saving of the grape crop may certainly be attained by spraying.

SUMMARY

In the first portion of this bulletin the serious losses from grape rots, more especially from what is herein referred to as white rot (*Coniothyrium Diplodiella*) are considered.

These losses threaten the grape industry in much of the grape belt skirting Lake Erie.

Certain varieties of grapes, such as Catawba, Niagara, Salem, etc., and others, are very susceptible to the attacks of this rot.

Other varieties, such as Moore's Early, Delaware, Salem, etc., are much more resistant to the rot, while the Concord variety occupies a somewhat intermediate position in this regard.

With like varieties a decided difference has been observed in the amount of rot in different soils; the hard, whitish silts, commonly known as clay soils, are much less favorable to rot than gravelly soils or others of higher fertility.

In the spraying experiments described in the second part of this bulletin careful treatment was applied upon a vineyard of about four acres of the Concord variety, situated near Geneva, Ashtabula county, Ohio.

The unsprayed portion yielded no marketable grapes for table use; likewise those portions treated with formalin, salicylate of soda and salicylic acid with lime. Unsprayed vineyards of the region showed like results. The most favorable results were obtained from eight applications of fungicides, including five of Bordeaux mixture and three of ammoniacal copper carbonate. Of these, two applications of Bordeaux mixture were made before the unfolding of the buds.

The omission of the spray upon the young shoots just before blossoming showed as a result a loss of 90 percent from black rot. Omissions of the earlier, or of the next later spraying, showed no decided losses.

The total beneficial result on this vineyard from the spraying already summarized was a saving of 50 percent of the possible marketable crop. Upon more favorable soils better results were obtained by private parties.

Upon the typical grape soils, and with moderately resistant varieties, such as the Concord, profitable results from spraying rot infected vineyards seven to nine times with standard fungicides, are indicated by these and other experiments.

The standard strength of Bordeaux mixture (4 lbs. of copper sulfate and 4 lbs of lime to 50 gallons of water) has proved equally as efficient as greater strengths. Slightly shorter intervals than two weeks between the sprayings are recommended after June 20th.

Almost total loss of the grape crop upon unsprayed vineyards in rot infected districts is predicated from the observations of the last two seasons.

CALENDAR OF STRIKING DATES IN GRAPE CULTURE FOR GENEVA—UNIONVILLE DISTRICT, 1899 AND 1900

Operations	1899	1900
Grape buds unfolding	About May 8	May 10
First spraying of Spray Calendar, second of these experiments		May 8-10
Frost injury	Slight, May 22	" 11
New shoots ½ feet long	May 27	" 28
Second spraying (third this experiment)		" 28
Grapes blossoming		June 11
Grapes out of blossom		" 21
Black rot prevalent		" 15-22
Third spraying (fourth this experiment)		" 22-23
First observed white rot	June 27-29	" 25
Fourth spraying (fifth this experiment)		July 2 and 3
Fifth spraying (sixth this experiment)		" 12
Sixth spraying (seventh this experiment)		" 27
Rot disastrously prevalent	July 9-12	Aug. 3-10
Seventh spraying (eighth this experiment)		" 14-15
Concords coloring		" 21
Began picking early sorts		" 29-Sept. 1
" " Concords		Sept. 10
Completed picking Concords		Oct. 20